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Factors affecting the client-veterinarian communication and breaking bad news in companion animal practice in Italy

Micaela Cipolla*, Luigi Bonizzi, Alfonso Zecconi

*Department of Veterinary Medicine
Università degli Studi di Milano - Italy*

Abstract: Client-veterinarian communication increases client satisfaction and compliance as well as the welfare of companion animals. Conversely, poor communication affects the health and the welfare of both humans and animals, mainly in a critical circumstance such as breaking bad news. In many countries, the veterinary education programs included also this skill, but in Italy these aspects are poorly considered and no data are available. The purpose of this study was to survey pet owners in order to investigate the factors affecting the client-veterinarian communication and the client's satisfaction with communication and breaking bad news. The 78.7% of the participants considered the pet a family member; owner's gender, household composition and pets in the household affected significantly how the pet was considered. How the participants considered the pet was significantly associated with the perception of the bad news and this result was confirmed by a consistent and significant trend. The owner's gender affected significantly the perception of the veterinarian's role while delivering the bad news. After the news, 41.8% of participants thought the veterinarian did not share their grief or was insincere. The household composition affected the participant's satisfaction with communication. The outcomes showed the importance of pets to their owners and the difficulties experienced in receiving bad news. Results suggest that in companion animal practice there is not only an animal to treat, but also an owner-pet entity requiring specific communication skills. The owners might be afflicted by veterinary practice and this is a public health issue in a One Health perspective.

Key Words: communication, attitude, pets, breaking bad news, veterinary practice.

* *Corresponding Author:* micaela.cipolla@unimi.it

Introduction

The important role of communication in small animal practice has been widely recognized (Chadderdon et al., 2001; Coe et al., 2008; Shaw et al., 2012). It increases patient satisfaction and compliance as well as in human medicine (Grant et al., 2000; Kanji et al., 2012; Kurtz, 2005; Shaw et al., 2004) and, in many countries, the veterinary education programs included also this skill (Adams & Kurtz, 2006; Latham & Morris, 2007; May, 2007). Communication is as important as other clinical skills, both in food-producing and in companion animal practices (Author, 2015; Hall & Wapenaar, 2012; Jansen & Lam, 2012; Jansen et al., 2010; Kleen et al., 2011; Martin et al., 2004; Shaw et al., 2012). Particularly, the companion animal practice mirrors the human medicine approach and, in this case, the patient-provider interaction becomes a client-veterinarian interaction. Much attention has been devoted to this topic in veterinary medicine in North America and North Europe (Latham & Morris, 2007; Lund et al., 2009; Shaw et al., 2008). Conversely, in Southern Europe and specifically in Italy, these aspects are still poorly considered. This situation may lead to malpractice claims or complaints, as observed in human medicine (Beckman et al., 1994). Moreover, communication in veterinary clinical practice is important not only for veterinary practice but also for public health in a "One Health" perspec-

tive (Author et al., 2015). Indeed, the human health is linked to the small animal health on several levels; for example, zoonoses could be a threat due to the close cohabitation with a pet, and the human-animal bond phenomenon could improve the mental health. Therefore, a lack of communication skills could be a public health issue.

Communication problems and gaps are of even larger importance in a particular circumstance such as breaking bad news (BBN). In human medicine, the bad news has been defined as any news that drastically and negatively alters the patient's view of her or his future (Buckman, 1984). In a more detailed definition, the bad news is described as "situations where there is either a feeling of no hope, a threat to a person's mental or physical well-being, a risk of upsetting an established lifestyle, or where a message is given which conveys to an individual fewer choices in his or her life" (Bor et al., 1993). In these definitions, the recipient is the patient whose health is involved. In veterinary medicine, the recipient is not the patient, but the human living with the non-human patient. Therefore, the feelings described in the previous definitions are experienced by the owners and concern both the health and future life of their companion animal (Shaw & Lagoni, 2007). Previous studies reported that the death of a pet affects people emotionally, physically, socially and cognitively (Adams et al., 2000). The owner is involved in health decisions and is responsible for the companion animal's health and care at home. This pattern resembles pediatric clinical practice (Shaw et al., 2004), but with a specific and important difference: the parent is emotionally affected and always considers important the health of his/her child, but it is not necessarily so for people living with companion animals. In our view, this is the peculiarity of the veterinary practice, especially in areas where cultural reasons might promote a low consideration of animals. Indeed, the importance assigned to the pet by its owner depends on several factors, including cultural aspects and traditions (Brown, 2002). This may affect both the persons' response to bad news and the role of communication in veterinary practice (Adams et al., 2000). The delivery of bad news is a challenge for the veterinarian and represents a significant problem for the practice of veterinary medicine worldwide (Adams et al., 2000; Williams & Mills, 2000). Veterinarians have to deal with the death of a patient more often than other health care professionals, and they cope with death and euthanasia in different ways (Manette, 2004). In human medicine, many factors contribute to physician discomfort while delivering the bad news, including concerns on how the news will affect the patient, the perception of failure, the feeling of responsibility, feelings of frustration and lack of training (Buckman & Kason, 1992; Eggly & Tzelepis, 2001). These factors also affect companion animal veterinarians. As for client-veterinarian communication, studies on this specific topic have been performed mainly in North America and Northern Europe, where the attitudes towards the companion animals are generally different from other areas, such as Southern Europe and specifically Italy. In Italy, society shows a lower regard for animals. For example, the cemeteries for companion animals are rare, and the funeral rites are even more unusual and controversial. The condolences do not apply to the death of an animal. It is compulsory to burn the dead companion animals, and the burial on the owner's property is forbidden. This attitude also affects veterinary practice. Indeed, the most common practices are small ambulatories with one or two veterinarians, while hospitals with specialized staff are rare. Moreover, the veterinary nurse is not available because it is not recognized as a profession in Italy. In this scenario, identifying the best communication strategy is a challenge for veterinarians, because the owner's attitude may be different from the societal one. If the owner's attitude is relatively uncaring, applying patient-provider communication principles might be ineffective, because these principles assume that the receiver is emotionally involved and concerned for the animal's health. Otherwise, if the owner's attitude is different from the apparent society's attitude, the veterinarian has to be prepared to face the client's grief.

Therefore, to gain information useful to support the veterinarian activity, we designed a research project on the client-veterinarian communication in Italy, as a model for situations with

similar cultural and social environments. In Italy there are no data available on client-veterinarian communication. Therefore, the purpose of the study was to survey pet owners in order to investigate the factors affecting the client-veterinarian communication and the client's satisfaction with communication and breaking bad news.

Materials and Methods

Questionnaire

We developed a questionnaire with 23 closed-ended questions, divided into three parts. The first part (questions 1 to 8) explored sample characteristics, household composition, the type and the number of animals in the household. In this part, a specific question investigated how the owner considered his/her companion animal: just an animal or a family member. This question had six answers describing an increasing level of value attributed to the pet by its owner; the first three answers defined the pet just an animal, the last three a family member.

The second part of the questionnaire (questions 9 to 22) examined the experience of receiving bad news. In the survey, bad news was defined as "a negative information you received from your veterinarian regarding your companion animal, such as a disease that you consider serious or death". We asked to participants to consider a BBN experience occurred when they were directly involved, being veterinary clients and having a role in taking care of the pet. Among the different questions, the survey investigated how the participants viewed the experience and whether the veterinarian had an influence on how they perceived such situation. The questionnaire also asked how the bad news was delivered and whether they appreciated that choice. The survey then asked how they felt after receiving the bad news, whether they felt the veterinarian sharing the participant's concerns, whether there was physical contact with him/her and whether they were satisfied overall with the delivery of bad news. Finally, question 23 aimed to assess client satisfaction with the veterinarian's communication.

The study fulfilled the ethical requirements of the University. The survey was pretested on 10 students from the Biotechnology and Veterinary Medicine schools, assessing also the time required to complete the questionnaire, the clarity of layout and instructions. After the pretesting, the graphical layout had minimal modifications, and the questionnaire was applied to the study population.

Participants and data collection

The sample population included students at the very beginning of their first year from the Biotechnology and Veterinary Medicine schools. This sample population offered some advantages: it was easy to enroll the target population as well as to manage the questionnaire administration and collection. Moreover, this sample selection allowed for avoiding possible environmental bias when questionnaires are administered to clients in veterinary clinics and hospitals. Enrolling only students at the beginning of their first year avoids potential bias related to the professional information gained during courses. This sample could also offer a view on members of younger generations, who are new and future clients of the veterinarians.

We administered the questionnaires at the beginning of two mandatory lectures to reach all of the first-year students. The participation in the research was optional, no professors were present before or during the survey, and the students were free to leave the classroom at any time. Aims, methods, terms and conditions of the research were clearly described before submitting the questionnaire; we clearly stated that answering to the questionnaire was an acceptance of terms and conditions. We administered the questionnaire without any additional information that could influence the answers. The survey was anonymous and confidential; to ensure

privacy, all questionnaires were collected together in an opaque envelope.

After collection, survey responses were turned into standard categories and recorded in a database for statistical analysis. Finally, a check on the data file for transcription or entry errors was performed prior to the onset of statistical analysis.

Data analysis

All questionnaires were analyzed by χ^2 test, applying the FREQ procedure of SAS 9.2 (SAS Institute, Cary NC). If the frequency of a cell was < 5 , Fisher's exact test was applied with StatXact software (Cytel Corp., Cambridge, MA). When three or more responses were identified in a category, the presence of a potential trend was assessed with the Cochran-Armitage trend test on StatXact software (Cytel Corp., Cambridge, MA). The significance level was set at $\alpha=0.05$.

We considered valid each questionnaire with no more than one missing answer.

Results

The number of respondents who had experience as a pet owner defined the sample size: overall, we considered 108 valid questionnaires out of the 145 collected, because 37 participants declared to have no pets. Therefore, the response rate was 100%. Sixty-five respondents were females, and 43 were males. The ages ranged from 19 to 29 years, with 48 respondents under 20 years and 60 between 21 and 29 years. Table 1 reports a detailed description of the frequencies for respondents' characteristics, while Table 2 reports data on the subset of respondents who had a BBN experience.

Table 1. Distribution of respondents' characteristics obtained from the 108 questionnaires considered.

| Factor | Category | N | % |
|--|-----------------|----|------|
| Gender | Female | 65 | 60.2 |
| | Male | 43 | 39.8 |
| Household composition | ≤ 2 | 6 | 5.6 |
| | 3 | 26 | 24.1 |
| | 4 | 58 | 53.7 |
| | > 4 | 18 | 16.7 |
| Companion animals in the same household | < 3 | 5 | 4.7 |
| | 3 | 26 | 24.3 |
| | 4 | 58 | 54.2 |
| Number of animal species in the same household | 5 or more | 18 | 16.8 |
| | 1 | 57 | 52.8 |
| | 2 | 30 | 27.8 |
| How do you consider your companion animal? | 3 or more | 21 | 19.4 |
| | Just an animal | 23 | 21.3 |
| Are you satisfied with veterinarian's communication? | A family member | 85 | 78.7 |
| | Yes | 87 | 80.6 |
| | No | 21 | 19.4 |

The respondents were owners of several animal species. Many of them had more than one species at the same time: 27.8% of respondents had two different species, and 19.4% had three or more. When only respondents who experienced BBN were considered, these frequencies changed and a larger number of owners of two or more different species was observed (Table 2). Twenty-three (21.3%) of respondents considered the companion animal just an animal, while 85 (78.7%) considered it a family member. Among the latter, the majority (42.6%) gave a higher value to the companion animal ("a family member with whom I have a special relationship", "my son/daughter").

Table 2. Distribution of respondents' characteristics obtained from the 55 questionnaires involving BBN.

| Factor | Category | N° | % |
|--|-----------|----|------|
| Gender | Female | 38 | 69.1 |
| | Male | 17 | 30.9 |
| Household composition | ≤3 | 14 | 25.5 |
| | 4 | 34 | 61.8 |
| | >4 | 7 | 12.7 |
| Number of animal species in the same household | 1 | 24 | 43.6 |
| | 2 | 16 | 29.1 |
| | 3 or more | 15 | 27.3 |
| Gender of the veterinarian | Male | 35 | 63.6 |
| | Female | 20 | 36.4 |
| Dogs in the same household | 0 | 15 | 27.3 |
| | 1 | 25 | 45.4 |
| | ≥2 | 15 | 27.3 |
| Cats in the same household | 0 | 30 | 54.5 |
| | 1 | 10 | 18.2 |
| | ≥2 | 15 | 27.3 |

Table 3 reports the outcomes of the analyses on factors affecting the participants' attitude towards companion animals. Some factors were significantly associated with how the companion animal is considered. Indeed, females were more inclined to consider the companion animal a family member when compared to males (χ^2 test; $p = 0.02$). Moreover, the importance of the companion animal decreased when family size increased, with a significant trend on the Cochran-Armitage trend test ($p = 0.03$). A significant trend ($p = 0.05$) was also observed for cat owners; indeed, as the number of cats increased, the frequency of respondents considering the companion animal a family member also increased.

Table 3. Factors affecting how the companion animal is considered by respondents.

| Factor | Category | How the companion animal is considered | | χ^2 or Fisher's exact test | Armitage Trend Test |
|--|-----------|--|-----------------|---------------------------------|---------------------|
| | | Just an animal | A family member | | |
| Gender of the owner | Female | 9 (13.8%) | 56 (86.1%) | $p = 0.02$ | n.p. ¹ |
| | Male | 14 (32.6%) | 29 (67.4%) | | |
| Household composition (people) | ≤2 | 0 (0.0%) | 6 (100%) | n.s. ² | $p = 0.03$ |
| | 3 | 4 (15.4%) | 22 (84.6%) | | |
| | 4 | 12 (20.7%) | 46 (79.3%) | | |
| | >4 | 7 (38.9%) | 11 (61.1%) | | |
| Number of animal species in the same household | 1 | 13 (22.8%) | 44 (77.2%) | n.s. | n.s. |
| | 2 | 7 (23.3%) | 23 (76.7%) | | |
| | 3 or more | 3 (14.3%) | 18 (85.7%) | | |
| Dogs in the same household | 0 | 10 (25.0%) | 30 (75.0%) | n.s. | n.s. |
| | 1 | 8 (17.8%) | 37 (82.2%) | | |
| | 2 or more | 5 (21.7%) | 18 (78.3%) | | |
| Cats in the same household | 0 | 14 (25.9%) | 40 (74.1%) | n.s. | $p = 0.05$ |
| | 1 | 7 (22.6%) | 24 (77.4%) | | |
| | 2 or more | 2 (8.7%) | 21 (91.3%) | | |

¹ not pertinent² not significant

Based on the whole set of data, factors affecting clients' satisfaction with the veterinarians' communication were analyzed and reported in Table 4. Among these factors, only household composition showed a significant effect (χ^2 test; $p = 0.008$). Respondents from families with four

or fewer components expressed a higher satisfaction compared with respondents from larger families. However, none of the trends were statistically significant. Unexpectedly, how the companion animal was considered was not associated with satisfaction. Indeed, the frequency of satisfaction when the companion animal was considered a family member was 81%, compared to 82.6% when it was not considered a family member.

Table 4. Factors affecting the owner's satisfaction in the 108 questionnaires considered.

| Factor | Category | Are you satisfied with veterinarian's communication? | | χ^2 or Fisher's exact test |
|---|---------------|--|------------|---------------------------------|
| | | No | Yes | |
| Gender | Female | 11 (17.2%) | 53 (82.8%) | n.s. ¹ |
| | Male | 9 (20.9%) | 34 (79.1%) | |
| How companion animal is viewed | Animal | 4 (17.4%) | 19 (82.6%) | n.s. |
| | Family member | 16 (19.0%) | 68 (81.0%) | |
| Household composition | ≤2 | 1 (16.7%) | 5 (83.3%) | p = 0.008 |
| | 3 | 6 (23.1%) | 20 (76.9%) | |
| | 4 | 5 (8.8%) | 52 (91.2%) | |
| | >4 | 8 (25.0%) | 10 (55.6%) | |
| Number of animal species in the same household | 1 | 11 (19.3%) | 46 (80.7%) | n.s. |
| | 2 | 6 (20.7%) | 23 (79.3%) | |
| | 3 or more | 3 (14.3%) | 18 (85.7%) | |
| Dogs in the same household | 0 | 11 (28.2%) | 28 (71.8%) | n.s. |
| | 1 | 5 (11.1%) | 40 (88.9%) | |
| | 2 or more | 4 (17.4%) | 19 (82.6%) | |
| Cats in the same household | 0 | 9 (17.0%) | 44 (83%) | n.s. |
| | 1 | 8 (25.8%) | 23 (74.2%) | |
| | 2 or more | 3 (13.0%) | 20 (87.2%) | |

¹ not significant

Bad news

Fifty-five participants had experience of receiving bad news, so the response rate was 50.9%. Among this subset of data, participants described the BBN experience as terrible or bad in 85.4% of cases, but in only 61.8% of cases they felt very sad, and in 9.1% of cases the economic aspects influenced their feeling. Overall, 80% of the participants were satisfied with the delivering of bad news. After the news, the majority of participants (61.8%) were very sad, and 41.8% of respondents thought that the veterinarian did not share their concern or was not sincere and pretended to share it. Only 3.6% reported physical contact between the veterinarian and the client; most respondents described physical distance and appreciated it, even though 5.5% of them would have preferred physical contact. Overall, 9.1% of participants reported the client's need for physical contact with the veterinarian while delivering the bad news.

In the majority of cases (85.4%), the room was large enough to accommodate all family members, and the time given to understand the bad news was adequate. All of the respondents who described the place as inadequate considered the companion animal a family member.

Veterinarians who delivered bad news were mostly men (63.6%). In almost all cases (96.4%), bad news was delivered in a face-to-face encounter, and all participants appreciated this choice. The veterinarian delivered bad news directly, using the name of the disease (90.9%), and almost all participants (96.4%) appreciated this method.

In most cases, the words used were clear and simple (96.4%); the veterinarian explained the problem to help the owner to understand the situation (98.2%) and explained every therapeutic choice (92.7%). All respondents who felt that the veterinarian did not explain all the therapeutic

alternatives considered the companion animal as a family member

Among the questions related to BBN, differences in responses were observed for a few parameters (place, grief sharing, discussion of therapeutic options, gender of veterinarian and veterinarian's behavior). These parameters were also analyzed in relation to the client's BBN experience. The statistical analysis showed that there was no association between the BBN experience and the veterinarian's behavior, e.g., whether he/she was kind, irrelevant or bad; whether he/she shared the owner's grief; whether he/she tried to explain all therapeutic options (data not shown).

When considering the BBN experience and the owner's characteristics (Table 6), data analysis showed a positive significant association between the perception of the experience and the value attributed to the companion animal ($p = 0.0149$). Indeed, 50% of participants considering the companion animal a family member described the BBN experience as terrible, while if the companion animal was viewed as just an animal the experience was never terrible and was "not a problem" in 33.3% of the cases. However, analysis showed an unexpected result: 10.9% of respondents viewing the pet as a family member described the BBN experience as not a bad moment, although there was a consistent and significant trend in the worsening of the experience ($p < 0.0075$) when the companion animal was considered a family member. To explain this result, a cross analysis was performed, also considering how people felt after receiving bad news. Data showed that 25.9% of respondents viewing the companion animal as a family member were not sad after the bad news (data not shown). This result suggests the need for further studies to investigate more thoroughly this specific aspect. When considering the BBN experience and the owner's characteristics, there was a numerical evidence: the majority of people owning two (43.8%) and three or more (60%) species at the same time described the BBN experience as terrible, while the experience was just bad for the majority (58.3%) of people living with only one species.

Table 6. Statistical analysis of BBN sample classified by BBN experience (respondent).

| Factor | Category | How would you describe the BBN experience? | | | χ^2 or Fisher's exact test | Armitage Trend Test |
|--|---------------|--|------------|---------------|---------------------------------|---------------------|
| | | Terrible | Bad | Not a problem | | |
| Gender of the owner | Female | 17 (44.7%) | 14 (36.8%) | 7 (18.4%) | n.s. ¹ | n.s. |
| | Male | 6 (35.3%) | 10 (58.8%) | 1 (5.9%) | | |
| How the companion animal is viewed | Animal | 0 (0.0%) | 6 (66.7%) | 3 (33.3%) | p=0.0149 | p=0.0075 |
| | Family member | 23 (50.0%) | 18 (39.1%) | 5 (10.9%) | | |
| Household composition (people) | ≤3 | 8 (57.1%) | 6 (42.9%) | 0 (0.0%) | n.s. | n.p. ² |
| | 4 | 12 (35.3%) | 15 (44.1%) | 7 (20.6%) | | |
| | >4 | 3 (42.9%) | 3 (42.9%) | 1 (14.3%) | | |
| Animal species in the same household | 1 | 7 (29.2%) | 14 (58.3%) | 3 (12.5%) | n.s. | n.p. |
| | 2 | 7 (43.8%) | 6 (37.5%) | 3 (18.8%) | | |
| | 3 or more | 9 (60.0%) | 4 (26.7%) | 2 (13.3%) | | |
| Dogs in the same household | 0 | 6 (42.9%) | 6 (42.9%) | 2 (14.2%) | n.s. | n.s. |
| | 1 or more | 17 (41.5%) | 18 (43.9%) | 6 (14.6%) | | |
| Cats in the same household | 0 | 10 (34.5%) | 15 (51.7%) | 4 (13.8%) | n.s. | n.s. |
| | 1 or more | 13 (50.0%) | 9 (34.6%) | 4 (15.4%) | | |
| How was the veterinarian during the BBN? | Kind | 11 (37.9%) | 14 (48.3%) | 4 (13.8%) | n.s. | n.p. |
| | Irrelevant | 10 (43.5%) | 10 (43.5%) | 3 (13.0%) | | |
| | Bad | 2 (66.7%) | 0 (0.0%) | 1 (33.3%) | | |

¹ not significant

² not pertinent

Table 7 describes the role of client's gender on the emotional response to the veterinarian's communication and behavior. Clients' gender influenced the perception of the veterinarian sharing the client's concerns, even if the significance level was not achieved ($p=0.08$). The frequency of positive answers was higher for females than for males, who considered the veterinarian insincere or not sharing their concern in 59% of cases. This result was supported by the significantly higher frequency of females judging the veterinarian as kind (82.8%), while 52.2% of males considered the veterinarian irrelevant in the BBN experience. The veterinarian was defined as irrelevant when he/she played no role in how the owner felt and experienced the delivery of bad news. More females than males considered the vet bad, but this latter result is based only on 3 respondents. How the companion animal is viewed was analyzed for the same set of responses and no statistically significant results were observed.

Overall, people who received bad news were more satisfied with routine client-veterinarian communication than the entire sample (87.3% vs. 80.6%), but were less satisfied with communication related to the BBN experience (80%). No one who considered the companion animal just an animal was unsatisfied with the bad news delivery.

Table 7. BBN sample: association between owner's gender and response to veterinarian's communication.

| Question | Category | Female | Male | χ^2 |
|---|---|------------|------------|-------------------|
| Did the veterinarian attend to your problem or share your grief and concern? | Yes | 25 (65.8%) | 7 (41.2%) | n.s. ¹ |
| | No/ I don't think he/she was sincere | 13 (56.5%) | 10 (43.5%) | |
| Did the veterinarian explain every therapeutic option in order to let you make the best choice? | Yes | 34 (66.7%) | 17 (33.3%) | n.s. |
| | No | 4 (100%) | 0 (0.0%) | |
| Was the place where bad news was delivered adequate? | Yes | 32 (84.2%) | 15 (15.8%) | n.s. |
| | No | 6 (88.2%) | 2 (11.8%) | |
| Are you satisfied with the delivery of bad news? | Yes | 31 (81.5%) | 13 (18.5%) | n.s. |
| | No | 7 (78.5%) | 4 (23.5%) | |
| Are you satisfied with veterinarian's communication? | Yes | 34 (89.5%) | 14 (10.5%) | n.s. |
| | No | 4 (82.4%) | 3 (17.6%) | |
| How was the veterinarian during the BBN? | Kind | 24 (82.8%) | 5 (17.2%) | p=0.01 |
| | Irrelevant | 11 (47.8%) | 12 (52.2%) | |
| | Bad | 3 (100%) | 0 (0.0%) | |

¹ not significant

Discussion

This study is the first, in our knowledge, on client-veterinarian communication performed in Italy, where there are no courses on communication for veterinarians in veterinary curricula and where society apparently places little value on animals. The Italian situation is different from the ones in North America and North Europe, where previous studies were performed, and could provide different and complementary data useful to increase our knowledge of the communication dynamics in small animal practice.

In this study, companion animals were considered family members in most cases. Respondents often considered their pet even more than a simple relative: it was the relative with whom they have a special relationship. Our sample population could have influenced the high number of respondents who viewed the companion animal as a family member. Indeed, even if it is not applicable to students of the Biotechnology School, the students of the Veterinary School could be more predisposed to love animals. Despite this potential bias, still a good proportion of respondents viewed the companion animal as just an animal, supporting the view of people

placing little value on pets. This outcome is very important because how the companion animal is considered affected most of communication-related aspects in BBN. For example, the consideration of the companion animal was significantly associated with the perception of the BBN experience. Indeed, we observed a consistent and significant trend towards a worsening of the experience when the owners regard their animals as family members. The bad news was bad, independent of veterinarian behavior, because it was related to the bond between the owner and the companion animal. The non-significant relationship between the BBN experience and the veterinarian's role also supported this aspect, suggesting that client emotions were mainly influenced by his/her relationship with the pet.

Our study showed several pieces of numerical evidence that those who considered the companion animal just an animal seemed to have lower expectations compared to those who viewed the pet as a family member and, in this case, communication seemed to be less critical. This outcome is in agreement with previous studies, suggesting that the increase of companion animal importance parallels the increase in demands and expectations (Lund et al., 2009). For example, all respondents who viewed the companion animal as just an animal were satisfied with BBN, and all they felt that the place of bad news delivering was adequate. Moreover, they were all persuaded that the veterinarian tried to explain every therapeutic choice, to make the clients understand what was possible and to let them make the best choice. No one who viewed the pet as just an animal judged the veterinarian as bad during the BBN experience, but all they described the veterinarian as kind or irrelevant. Conversely, people who viewed the companion animal as a family member thought that in some cases the veterinarian could have done more. All people who were disappointed by the veterinarian's communication considered the companion animal a family member, as well as who felt that the veterinarian's explanations and the place where bad news was delivered were inadequate. All these aspects should be investigated in the next step of the research in a larger sample.

This study suggests the description of an initial profile of the clients with high expectations, based on the importance of the pet, household composition and respondent's gender in the whole sample. Considering the attachment to the pet, the results show some important statistically significant aspects: the importance of the companion animal increased when the number of family members decreased and when the owner's gender was female, in agreement with previous studies (Adams et al., 2000; Ramon et al., 2010). Also the species influenced how the participant viewed the pet: there was a consistent and significant trend in considering the cat a family member when the number of cats in the same household increased. This could be explained considering the prominent affective role of cats, that are only companion animals and do not have other roles, as do guard or hunting dogs. Similarly, even though statistically not significant, the pet was viewed as a family member more frequently when three or more species were present in the same household. This finding could be due to the possibility that people who have a special affection for animals are likely to have more pets than average. Furthermore, people with more companion animals have a greater chance of experience the receiving of bad news, and this could explain the increased number of owners of two or more different species in the bad news sample. In the whole sample, household composition significantly influenced participants' satisfaction with communication: larger families were less satisfied. This could be due to a greater difficulty in communicating effectively when a larger number of people are involved. In addition, the owner's gender should be considered in the evaluation of communication, because affected significantly the perception of veterinarian's role while delivering the bad news. For example, males appeared less inclined to be influenced by veterinarian's behavior. Moreover, numerically females were more convinced than males that the veterinarian attended to and shared their concern.

The veterinarian should consider the emotional aspect; indeed, a lack of awareness may affect the communication approach with the owner and has the potential to increase his/her grief (Buckman & Kason, 1992; Lagoni & Durrance, 2011). In our study, after a BBN experience, 41.8%

of participants thought the veterinarian did not share their grief or was insincere. This is a problem for the client-veterinarian interaction, and veterinarians should take it into consideration, making efforts to increase their respect for the owners' distress and assure better communication. Therefore, this skill should be improved, also bearing in mind that the companion animal could have great significance and value to its owner. Indeed, despite cultural and ethnic differences, our outcomes are in agreement with previous studies (Ramon et al., 2010; Risley-Curtiss et al., 2006; Schoenfeld-Tacher et al., 2010) and confirm the importance of the companion animal for its owner, even when the societal environment seems to have a low attitude towards animals. However, some participants considered their pet just an animal. This different attitude of the owners affected the client-veterinarian communication and showed the importance of communication in companion animal practice, because veterinarians have to be prepared to face different types of owners by using different communication strategies. Moreover, communication in veterinary clinical practice is important not only for veterinary practice but also for public health in a One Health perspective (Author et al., 2015) via the human-animal bond phenomenon (Lagoni et al., 1994; "One Health Initiative One Health Initiative; Mission statement"; Shepherd, 2008). The results showed that, in many cases, the veterinarians are managing not "an animal" but a family member who has a demanding human relative affected by veterinary practice, and this is a relevant aspect of public health. However, directly importing in veterinary practice what is observed in human medicine is not the solution, because in companion animal practice there is not only a patient to treat, but also an owner-pet entity requiring specific communication skills. For this reason, the peculiarities of the veterinary field should be considered and thoroughly investigated.

The outcomes of this study are promising, and should be confirmed in a larger and more representative sample. Moreover, it could be interesting to investigate the same participants in the future, to assess potential changes when an owner becomes a veterinarian. Similarly, it could be interesting to verify whether their attitude changes as they progress through veterinary school, as it has been observed in medical students (Hojat et al., 2004). Only the data collection mode affected the return rate: we administered the questionnaire also to participants with no pets. Despite this problem, the questionnaire proved to be a useful tool to investigate the owner's attitudes towards companion animals and factors affecting the client's satisfaction with the client-veterinarian communication. The initial data supplied by this study could be useful to understand the client-veterinarian communication and the delivery of bad news where veterinarians are not specifically trained or where social norms apparently place little value on animals. The pattern described could be used as a reference for countries or situations with similar societal attitudes and cultural environments. Independently of the location, practical implications of these results will allow the improvement of veterinary practice and the increase of client comfort, satisfaction and well-being. Moreover, our results are an initial contribution to describing the attitudes towards companion animals in European countries, complementing previous results from Northern Europe (Denneberg & Egenvall, 2009; Latham & Morris, 2007; Lund et al., 2010; Lund et al., 2009).

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Fattori che influenzano la comunicazione tra il veterinario ed il cliente e la comunicazione delle cattive notizie nella pratica degli animali da compagnia in Italia

Micaela Cipolla, Luigi Bonizzi, Alfonso Zecconi

Dipartimento di medicina Veterinaria, Università degli Studi di Milano - Italia

Sintesi

Una buona comunicazione tra cliente-veterinario aumenta la soddisfazione del cliente e la compliance come pure il benessere degli animali. Al contrario, una comunicazione scarsa influenza negativamente la salute ed il benessere di persone ed animali, soprattutto in circostanze critiche quali la comunicazione di cattive notizie.

In molti paesi I programmi formative per veterinari includono anche queste abilità ma in Italia questi aspetti sono poco considerati e non esistono dati disponibili al riguardo.

Lo scopo di questo studio è stato quello di analizzare i fattori che influenzano la comunicazione veterinario-cliente e la soddisfazione del cliente riguardo al modo in cui gli sono riferite cattive notizie riguardanti la salute del proprio animale.

Il 78,7% degli intervistati considera l'animale da compagnia come un membro della famiglia; il sesso del proprietario, la composizione della famiglia e gli animali presenti in casa influenzano significativamente il modo in cui è considerato il pet.

Questo aspetto è risultato associato in modo significativo con la percezione delle cattive notizie. Il genere del proprietario influenza significativamente la percezione del ruolo del veterinario nel comunicare cattive notizie. Dopo la comunicazione di una brutta notizia, il 41,8% dei proprietari pensa che il veterinario non condivida il loro dolore o che non sia stato sincero.

I risultati sottolineano l'importanza dell'animale da compagnia per i proprietari e la difficoltà che essi sperimentano nel ricevere cattive notizie riguardanti i propri pet. Questi dati inoltre suggeriscono di porre attenzione al fatto che nella pratica veterinaria dedicata agli animali da compagnia, non vi è solo l'animale di cui prendersi cura ma anche il proprietario che richiede una particolare abilità comunicativa.

Dog attention towards the owner in two insoluble problem-solving tasks: a pilot study about the effect of skull conformation and selection to cooperate with man

Marcella Zilocchi^{1*}, Maristella Giordano², Asahi Ogi¹

¹ *Department of Veterinary Sciences, University of Pisa, Italy*

² *Dog trainer freelance*

Abstract: The aim of this study was to evaluate whether brachycephalic breeds selected for companionship or for utility behave differently for the attention paid to the owner in two insoluble problem-solving tasks. Eleven adult dogs, 5 belonging to companion breeds and 6 belonging to breeds selected for utility were involved. The study consisted of two behavioral tests (“bin-opening” and “rope-pulling”). After the training, dogs were subjected to two kinds of insoluble problem-solving tasks, evaluating the latency of the first gaze toward the owner and the number of these gazes. The statistical analysis did not show any differences in the first test “bin-opening” (latency: $U = 13.5$, $p = 0.93$; number of gazes: $U = 14.5$; $p = 0.79$) nor in the second one “rope-pulling” (latency: $U = 13.5$, $p = 0.93$; number of glances: $U = 11.0$; $p = 0.54$). Our preliminary results suggest that within the group of brachycephalic dogs there are no differences in the attention paid to the owner in situations that require collaboration with him/her, despite the different selection carried out within this group of dogs according to the functions to be performed by different breeds. Given the small number of subjects tested, further research is needed to verify whether the selection for fighting influence the human-directed gazing.

Key Words: attention to owner, brachycephalic, dog, problem solving.

* *Corresponding Author:* zilocchi@vet.unipi.it

Introduction

Paedomorphosis has enabled the creation of many canine breeds differing for both morphology and certain behavioral traits. Based on the cephalic index, breeds are classified as dolichocephalic, mesocephalic or brachycephalic. Brachycephalic breeds are considered neotenic because the development of their behavior and of some parts of their body (e.g. the muzzle) is blocked at a very early stage compared to the result of the wolf (Coppinger et al., 1987). Besides physical differences, there are also considerable differences in the behavior depending on the breed. Trainability of the dog is one of the more studied aspects of canine behavior. Undoubtedly dog trainability is based both on the ability to maintain dog’s attention on the owners and on the motivation to cooperate with them.

The aim of this study was to evaluate whether brachycephalic breeds, selected for companionship or for utility, behave differently for the attention paid to the owner in two insoluble problem-solving tasks.

Materials and methods

Eleven adult dogs, 5 belonging to companion breeds (2 Pugs, 2 French Bulldogs, and 1 Cavalier King Charles Spaniels; 3 males and 2 females) and 6 belonging to breeds selected for utility

(2 American Pitbull Terriers, 2 American Staffordshire Terriers, 1 Rottweiler, and 1 Boxer; 4 females and 2 males), were involved. The study consisted of two behavioral tests: “bin-opening” (Fig. 1) and “rope-pulling” (Fig. 2), (Miklósi et al., 2003).



Fig. 1. Bin-opening test.



Fig. 2. Rope-pulling test.

Both brachycephalic breeds (companion and utility) were given the opportunity to learn how to solve the problem situation in six repeated training trials. After the training, dogs were subjected to two kinds of insoluble problem-solving tasks.

The first consisted in trying to reach food located in a container having a closed lid (“bin-opening”).

In the second test, the dog had to retrieve the food tied to a rope and placed inside a wire mesh cage (“rope-pulling”). After the dogs had mastered the task, that is, they opened the bin (which contained a piece of meat) or pulled out a rope (with a piece of meat attached to its end) from a cage, within 20s from the moment it was released from the leash, in the 80% of the trials, the researcher presented the dogs with the same problem, but this time the problem was insoluble (“blocked test trials”: bin was closed mechanically; a hidden end of the rope was fastened to the cage).

From the moment the dog was freed from the leash, two minutes were timed: during this time, the first look at the owner and the number of glances towards him were noted.

The statistical analysis carried out using Mann-Whitney test ($p < 0.05$) to compare the two groups.

Results

Statistical analysis did not show any differences between the two groups in both tests (Fig. 3; Fig. 4). In fact, in the “bin-opening” test, any difference was not detected in the latency of the first glance ($U = 13.5$, $p = 0.93$) and in the number of gazes ($U = 14.5$; $p = 0.79$). Also in the “rope-pulling” test no difference was noted (latency: $U = 13.5$, $p = 0.93$; number of glances: $U = 11.0$; $p = 0.54$).

Discussion

These preliminary results suggest that, within the group of brachycephalic dogs, there are no differences in the attention paid to the owner in situations that require collaboration with him/her, despite the different selection carried out within this group of dogs, according to the functions to be performed by different breeds. The lack of differences may be due to the relevance of experience on the display of dog behavior. In fact, behavior is due to both environmental and genetic factors.

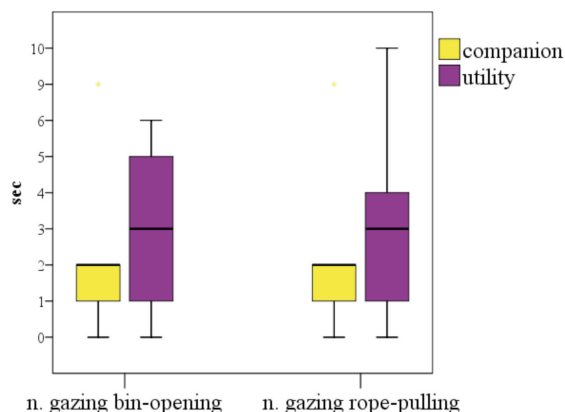


Fig. 3. Number of glances directed to the owner in the two behavioral tests considered.

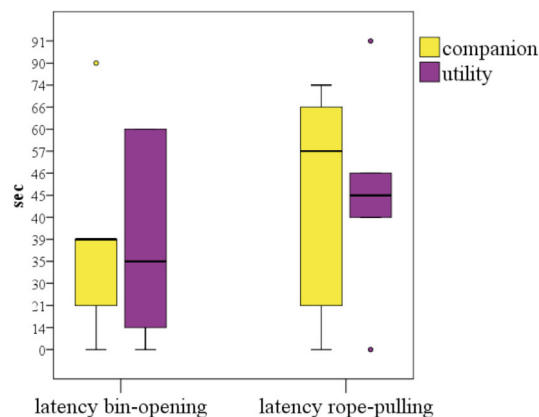


Fig. 4. Latency of the first glance directed to the owner in the two behavioral tests considered.

Brachycephalic dogs are probably selected for tenacity (Gazzano et al., 2015), and this can go to the detriment of motivation to cooperate with the owner. However, gazing behavior is strongly affected by the relationship with the owner (Mariti et al., 2013) as well as by other factors such as everyday life.

Conclusions

Given the small number of subjects tested, further research is needed to verify whether the selection for fighting influence the human-directed gazing.

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L'attenzione del cane nei confronti del proprietario: uno studio pilota sull'effetto della conformazione del cranio e della selezione per la cooperazione con l'uomo

Marcella Zilocchi¹, Maristella Giordano², Asahi Ogi¹

¹ Dipartimento di Scienze Veterinarie, Università di Pisa, Viale delle Piagge, 2 56124 Pisa

² Istruttore cinofilo libero professionista

Sintesi

Lo scopo dello studio è stato quello di valutare se individui appartenenti a razze brachicefale, selezionate come animali da compagnia o per utilità e difesa, si comportino in modo diverso per quanto riguarda l'attenzione rivolta

al proprietario nel tentativo di risolvere una prova impossibile. Undici cani adulti, 5 appartenenti a razze da compagnia e 6 a razze selezionate per l'utilità e difesa, sono stati reclutati per la ricerca.

Lo studio consisteva in due test comportamentali: "bin-opening" (apertura di un contenitore) e "rope-pulling" (tirare una fune). Dopo un periodo di training la prova era resa irrisolvibile da parte del cane ed erano valutati la latenza del primo sguardo rivolto al proprietario ed il numero di sguardi. L'analisi statistica dei dati non ha mostrato differenze significative sia nel test "bin-opening" (latenza: $U = 13,5$; $p = 0,93$; numero di sguardi: $U = 14,5$; $p = 0,79$) sia nel "rope-pulling" (latenza: $U = 13,5$; $p = 0,93$; numero di sguardi: $U = 11,0$; $p = 0,54$).

Questi risultati preliminari suggeriscono che nel gruppo dei cani brachicefali, non ci siano differenze nell'attenzione rivolta al proprietario, in situazioni che richiedano la collaborazione con esso/a, nonostante la diversa selezione condotta sugli individui in base alle funzioni svolte dalle diverse razze.

Dato il piccolo numero di soggetti testati, ulteriori studi saranno necessari per verificare se la selezione per il combattimento influenzi il livello d'attenzione rivolta al proprietario.

Attitude towards pets in veterinary surgeons: a comparison between female and male veterinarians in Italy

Chiara Mariti^{1*}, Sabrina Giussani², Angelo Gazzano¹

¹ *Department of Veterinary Sciences, University of Pisa, Italy*

² *SISCA, Società Italiana Scienze del Comportamento Animale, Cremona, Italy*

Abstract: The aim of this study was to investigate possible gender differences in the attitude towards animals among companion animal veterinarians. The sample was made up of 337 veterinary surgeons involved in the clinic of small animals, 41.1±9.4 years old, graduated in the period 1974-2015, working in different areas of Italy. The sample was formed by 261 female and 76 male veterinary surgeons. The participants filled in a questionnaire included items regarding personal data as well as items related to welfare. Respondents' were asked to rate, using a 1-5 Likert scale, the importance of the Brambell's five freedoms for the welfare of pet species and their actual protection. The questionnaire also included the 20-item ethics subscale of the Animal Attitude Scale (AAS). Women showed a higher AAS total score (78.8±11.4 vs 72.1±13.7; U=7062.00; p<0.001). However, no difference was found between women and men for the items of AAS regarding pets, specifically where dog-fighting and dog shelters were mentioned. Women were found to consider more important, for the well-being of pets, the provision of an appropriate physical environment (U=7574.00; p<0.001), the freedom from fear and distress (U=8432.00; p=0.012) and the freedom to express normal behaviour (U=8400.00; p=0.012). Males were instead found to consider their patients more protected in their need to express normal behavior (U=8222.50; p=0.012). These findings confirm a strong influence of the gender on the attitude towards non-human animals: female veterinarians showed more concern for animal welfare issues than did males both in terms of sensitivity to animal use by humans and in importance given to the five freedoms for the welfare of pet animals.

Key Words: veterinarian, attitude towards pets, behaviourist.

* *Corresponding Author:* chiara.mariti@unipi.it

Introduction

The existence of gender differences in both attitudes and behaviour towards non-human animals is a widespread phenomenon. Herzog and colleagues (1991) found that gender and the expressive (feminine) dimension of sex role orientation accounted for a significant proportion of the variation in attitudes towards animal welfare issues. It is likely that such sex differences exist also in professional categories such as veterinary surgeons (Ozen et al., 2004).

The veterinary profession plays a significant role in animal welfare issues, particularly in research, clinical care, and the animal protection movement (Wu et al., 2015). Their positions and attitudes towards animal welfare are fundamental in preventing animals from unnecessary suffering and improving their welfare status in practice (Sabuncuoglu & Cabon, 2008).

The aim of this study was to investigate possible gender differences in the attitude towards animals among companion animal veterinarians.

Subjects, materials and methods

A convenience sample of veterinary surgeons working with dogs and cats was recruited through social networks, personal contact and word of mouth, and asked to participate at an online survey. The questionnaire included items regarding personal data as well as items related to welfare. Respondents' were asked to rate, using a 1-5 Likert scale (see tab. 1), the importance of the Brambell's five freedoms for the welfare of pet species and their actual protection. The questionnaire also included the 20-item ethics subscale of the Animal Attitude Scale (AAS) (Herzog et al., 1991). The AAS was back-translated into Italian, and item number 3 was modified using the word dog-fighting instead of cock-fighting.

The total sample was made up of 337 veterinary surgeons involved in the clinic of small animals, 41.1 ± 9.4 years old, graduated in the period 1974-2015, working in different areas of Italy. The sample was formed by 261 female and 76 male veterinary surgeons. The answers provided by the two genders were compared using the Mann Whitney U test ($p < 0.05$).

Results and discussion

The statistical analysis revealed significant gender differences in veterinary surgeons for most of the attitude measures. In detail, women showed a higher AAS total score (78.8 ± 11.4 vs 72.1 ± 13.7 ; $U = 7062.00$; $p < 0.001$) (Fig. 1). This confirms previous studies using the same questionnaire (e.g. in the general and in the animal protection community: Signal & Taylor, 2007). However, no difference was found between women and men for the items of AAS regarding pets, specifically where dog-fighting and dog shelters were mentioned. Herzog (2007) suggests that the overlap between genders on specific issues related to attitudes and behavior towards animals is higher than expected.

In the current study, other measurements were used. Women were found to consider more important, for the well-being of pets, the provision of an appropriate physical environment ($U = 7574.00$; $p < 0.001$), the freedom from fear and distress ($U = 8432.00$; $p = 0.012$), and the freedom to express normal behaviour ($U = 8400.00$; $p = 0.012$) (Fig. 2). Males were instead found to consider their patients more protected in their need to express normal behavior ($U = 8222.50$; $p = 0.012$) (Fig. 2). These findings also reflect previous studies assessing veterinary students (Serpell, 2005) and veterinary practitioners involved in different fields and dealing with different species (Ozen et al., 2004), in which females were found to display greater concern for animal suffering and welfare issues.

It is noteworthy that no difference was found for the very basic and physical-related freedoms, i.e. freedoms from hunger, thirst, pain, injury and disease. These freedoms were equally important for the two genders, maybe due to the fact that respondents were educated on these points during their veterinary career.

Female veterinary surgeons seem to be more sensitivity than males about psychological aspects, i.e. fear, distress and normal behavior. It is also remarkable that women considered their patients less protected in their need to express normal behavior. It is possible that women tend to express more concern for the welfare of individual animals (Kellert & Berry, 1987), and it may be related to a gender difference in rating the dogs' level of stress (Mariti et al., 2012). Such difference is likely to be relevant when veterinarians are called to assess and provide advice about their patients' welfare.

Tab. 1. Items on the importance and protection of the five freedoms listed in Brambell' Report (1965) and the relative Likert scales used.

| | Likert scale | Five freedoms |
|--|--------------------------|--|
| In your opinion, how much important are the freedom listed in the Brambell Report 1965 for the welfare of a companion animal? | 1 = not important at all | Freedom from hunger or thirst |
| | 2 = slightly important | Freedom to have an adequate physical environment |
| | 3 = moderately important | |
| | 4 = very important | Freedom from pain, injury or disease |
| | 5 = extremely important | |
| In your opinion, how much guaranteed are the freedom listed in the Brambell Report 1965 in your patients? | 1 = not protected at all | Freedom to express (most) normal behavior |
| | 2 = slightly protected | |
| | 3 = moderately protected | |
| | 4 = very protected | Freedom from fear and distress |
| | 5 = totally protected | |

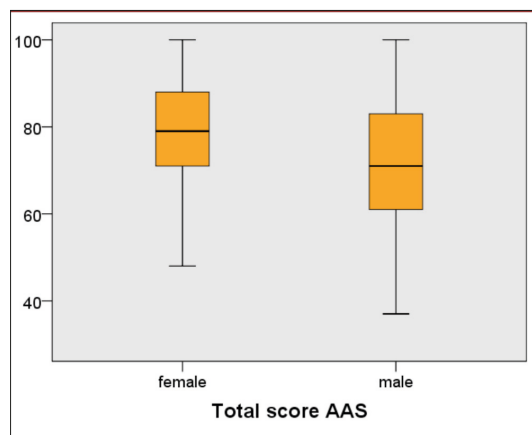


Fig. 1. Total scores obtained by female and male vets for the Animal Attitude Scale.

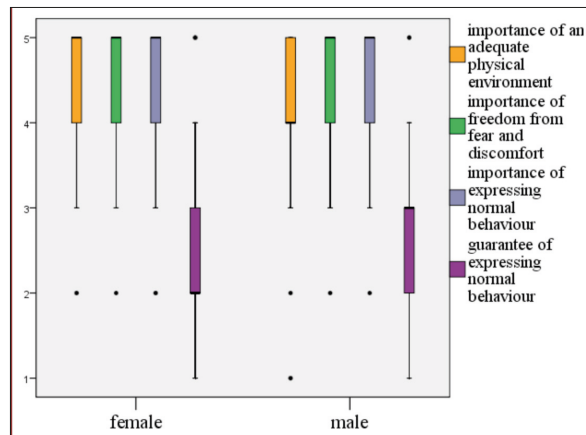


Fig. 2. Scores obtained by female and male vets which result in a statistically significant difference ($p < 0.05$).

Conclusions

These findings confirm a strong influence of the gender on the attitude towards non-human animals: female veterinarians showed more concern for animal welfare issues than did males both in terms of sensitivity to animal use by humans and in importance given to the five freedoms for the welfare of pet animals.

Further research should clarify whether such gender dissimilarity may imply relevant differences in the care of animal patients and in the suggestions provided to owners.

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L'attitudine per gli animali da compagnia nei veterinari: un confronto tra i veterinari di sesso maschile e femminile in Italia

Chiara Mariti¹, Sabrina Giussani², Angelo Gazzano¹

¹ *Dipartimento di Scienze Veterinarie, Università di Pisa, Italy*

² *SISCA, Società Italiana Scienze del Comportamento Animale, Cremona, Italy*

Sintesi

Lo scopo dello studio è stato quello di indagare sull'esistenza di possibili differenze attribuibili al sesso, nei veterinari di animali da compagnia.

È stato scelto un campione di 337 veterinari (261 donne), che esercitavano la professione nella clinica dei piccoli animali in diverse regioni italiane. L'età media è risultata essere di $41,9 \pm 9,4$ anni ed il conseguimento della laurea nel periodo compreso tra il 1974 ed il 2015.

I partecipanti hanno compilato un questionario che includeva domande riguardo la propria situazione anagrafica e concernenti le loro opinioni circa il benessere degli animali da compagnia.

Nello specifico, ai partecipanti era chiesto di esprimere l'importanza che attribuivano alle 5 libertà proposte da Brambell, usando i punteggi previsti dalla scala Likert. Il questionario includeva inoltre 20 domande a sfondo etico, appartenenti alla Animal Attitude Scale (AAS).

Le donne hanno mostrato un punteggio più alto di AAS ($78,8 \pm 11,4$ vs $72,1 \pm 13,7$; $U=7062,00$; $p<0,001$). Nessuna differenza è stata riscontrata nei punteggi di AAS riferiti agli animali da compagnia, specialmente quando erano menzionati i combattimenti tra cani e i canili.

Le donne considerarono più importante, per il benessere dell'animale, il fornire un ambiente fisico appropriato ($U=7574,00$; $p<0,001$), la libertà dalla paura e dallo stress ($U=8432,00$; $p=0,012$) e quella di poter esprimere un comportamento normale ($U=8400,00$; $p=0,012$).

Questi risultati, seppur preliminari, confermano l'esistenza di una forte influenza di genere nell'attitudine dei veterinari nei confronti degli animali. I veterinari di sesso femminile hanno riconosciuto una maggior importanza alle 5 libertà nel tutelare il benessere dell'animale.

Is dog domestication due to epigenetic modulation in brain?

Daniela Pörtl^{1*}, Christoph Jung²

¹ *Psychiatric Department, Saale-Unstrut Klinikum, teaching hospital Leipzig and Jena Universities, Naumburg, Germany*

² *Psychologist*

Abstract: Dogs (*Canis lupus familiaris*), derived from wolves (*Canis lupus*), are known as the first domesticated animal and dogs have been living in human environment for about 25.000 years. Today researchers tend to proclaim a self-domestication-process, but they are still figuring out, why and how this process started. During the Palaeolithic period, humans and wolves lived in similar structured family clans as cooperative hunters in the same ecological niche. Evolutionary continuity of mammalian brains enabled humans and wolves interspecific communication and social interaction which reduced stress and aggression during their frequently contacts as the first step of a natural domestication process. Domestication means decreased aggression and decreased flight distance concerning to humans. Therefore changes of the activity of the Hypothalamic-pituitary-adrenal (HPA) axis are suspected to be important during the domestication processes from wolf to dog. The hypothesis of Active Social Domestication (ASD) considers genetic selection as a necessary prediction but not a sufficient explanation of dog domestication. In addition dog domestication is suggested to be essentially an epigenetic based process that changes the interactions of the HPAaxis and the 5-Hydroxytryptamine (5-HT) system. The limbic brain regions such as hippocampus and amygdala play a key role in the mood control. They are sensitive to glucocorticoids and innervated by serotonergic projections. The HPAaxis and the 5-HT system are closely cross-regulated under physiological conditions. The activity of the HPAaxis is influenced thru an enhancement of the corpus amygdala and an inhibition thru the hippocampus. Hippocampal glucocorticoid receptor density (hGCR) is likely to affect its inhibitory effect on this system. Pro-social behaviour enhances epigenetically hGCR expression via increased serotonin and subsequently increased nerve growth factor levels binding on GRexon1;7promotorbloc inducing its demethylation and thus leading to decreased cortisol levels. Low cortisol levels increase social learning capability and promote the activity of the prefrontal cortex contributing to better executive function including better cognitive inhibition. Thus epigenetically decreased cortisol levels of less stressed human-associated wolf clans allowed them to extend their social skills to interactions with humans. Over time tame wolves could grow into domestic dogs able to emerge human directed behaviour.

Key Words: dog, wolf, domestication; stress-axis; epigenetics; coevolution.

* *Corresponding Author:* d.poertl@t-online.de

Today it is commonly accepted that dogs were domesticated as the first animal about 25.000 years ago (Thalman et al., 2013; Ovodov et al., 2011). But researchers are still figuring out, why and how this domestication process started. In the past it was common to follow the hypothesis founded by Lorenz (1967), who considered human hand reared wolf-pups as dog's ancestor. But even a hand reared wolf-pup taken during the first nine days of its live is as an adult wolf a potential risk for humans (Kubinyi et al., 2007) and it also needs a partner from the wild for reproduction. Therefore this hypothesis (Lorenz, 1967; Zimen, 1992) seemed rather unlikely and was dropped. Recent researchers tend to proclaim a self-domestication process. Coppinger (2001) argued, the waste dump was the place where dogs evolved. A population of wolves began to exploit the new ecological niche (Peterson et al., 2004) of scavenging human food remains and feces. Those wolves showed higher reproductive success and thus, from generation to generation they were selected to be more tolerant to humans as a kind of self-domestication

process. But archaeologists proclaim, that waste dumps are a characteristic of modern times (Havilcek, 2015; Pichtel, 2005). In the Paleolithic period people used all material of their prey. Archaeologists only found Stone Age dumps with fragments from making stone tools (Havilcek, 2015; Rust, 1948). Nevertheless it is common sense that dog domestication began in the Upper Paleolithic period, but human settlement started first in the Neolithic period (Thalman et al., 2013; Shipman, 2015). Therefore the hypothesis of dog domestication at the waste dump appears rather unlikely and should also be dropped, although the idea of a self-domestication occurs still plausible. Brian Hare evolved a hypothesis of self-domestication concerning primates and dogs in which social and friendly behaviour is suggested to be in the focus of the self-domestication process (Hare et al., 2012).

Wolves are very social mammals living as hunters in family clans rearing their pups together (Mech, 1999). They hunt in cooperative groups and use refined social communication consisting of complex mimicry, joint attention and howling (Mech, 2009). Gray wolves have been living in Europe for hundred thousands of years, but *Homo sapiens* immigrated to Europe about 45.000 years before our time and invaded the ecological niche of ancient wolves (Shipman, 2015). In these ancient times individuals of *Homo sapiens*, called human in the following, also lived as cooperative hunter-gatherers in family clans raising their children together (Hawkes, 2003; Page et al., 2017). Wolves and humans hunted mammoth, rhinoceros and other large herbivores from the Pleistocene using cooperative hunting strategies (Shipman, 2015). As a result, wolves and humans lived in cohabitation but also in competition during the Palaeolithic period. As social mammals both species were skilled with basic social communication gestures based on evolutionary conserved similar brain structures (Berns, 2012; 2013) which enabled them to interact and communicate with each other (Heberlein et al., 2016; Darwin 1910). Thus, they came into contact. Thalman et al. (2013) suggest an onset of dog's domestication approximately 18.800 to 32.100 years ago. Their study implies that "*domestic dogs are the culmination of a process that initiated with European hunter-gatherers and canids with whom they interact*".

There is evidence for fascinating confirmation about human partnership with early domesticated wolf-dogs soon after Neanderthals had disappeared. This alliance of two predator species allowed them an unprecedented degree of success in hunting large herbivores from the Pleistocene, and that it was a big evolutionary benefit for both (Shipman, 2015).

Neurobiology of human-wolf/dog communication

The evolutionary continuity of mammalian brains implies that basal brain systems like limbic system, stress axis and mirror neuron mechanism are evolutionary conserved in all mammalian brains (Ledoux, 2012; Gimpl & Fahrenholz, 2001; Reep et al., 2007; Ferrari, 2016). Mirror neuron mechanism is involved in empathy and mirror neurons start firing when both individuals are equipped with the same neuronal representation of an emotion or an action (Kilner & Lemon, 2013). Additional evidence suggests that mirror neurons are not inclusive to primates and humans. Today mirror neurons are experimentally verified in humans, primates and songbirds (Welberg, 2008) and it is reasonable to hypothesize that social mammals like wolves and dogs have mirror neurons, too (Ferrari, 2016). Humans' and wolves' similar learning experience should have created equal neuronal representations, coding the observed actions and emotions. Functional MRT studies proved that human mothers have similar brain activation in limbic brain regions when viewing their own child and their dog (Stoekel et al., 2014). On the other hand dogs and humans show a similar physiological response to human infant crying (Yong & Ruffman, 2014). Empathy and pro-social behaviour is not only known for humans, but also for many other animals like rodents, wolves and dogs (Bartel et al., 2011; Romero et al., 2014; Joly-Mascheroni et al., 2008). Domestic dogs have the ability to yawn contiguously

while watching human yawns and the contagiousness of human yawns in dogs correlate with the level of dog's social attachment to the yawning person (Romero et al., 2013). Romero's study (2013) demonstrates that dogs are capable of empathic abilities towards humans. Even wolves are vulnerable to contiguous yawning correlating with the level of social attachment within the pack (Romero et al., 2014). Further on it is commonly accepted that the neuropeptide oxytocin plays an important role in mammalian bonding, increasing empathy, social memory, trust and in-group behaviour (Lim & Young, 2006; Savaskan et al., 2008; Kosfeld et al., 2005). Nagasawa et al. (2015) show that gazing into each other's eye, a process mediated by the hormone oxytocin also exists between humans and their attached dogs. This mutual gazing increases oxytocin levels in both species indicating interspecific empathy. Even the reward system in brains of dogs and humans shows a similar functional mechanism. Functional MRT studies of awake unrestrained dogs indicated caudate activation in dog brains as a response to hand signals denoting reward versus no-reward similar to functional MRT-studies of human brains (Berns, 2012).

Because of the similar social behaviour like living in family clans (Mech, 1999; Hawkes, 2003; Page et al., 2017) and raising the off-spring together and because of using cooperative hunting strategies (Mech, 2009) in an identical environment (Shipman, 2015), humans and wolves should have had a similar learning experience in ancient times. Due to similar social behaviour and similar evolutionary conserved brain patterns (Reep et al., 2007) they should have been able to communicate with each other and thus, it was possible for both of them to become confident to each other (Range et al., 2014). We suppose that increased social contact between both species led to reduced stress and to improved pro-social behaviour and empathy (Beetz et al., 2012). From a neuro-chemical perspective cortisol levels decreased and serotonin and oxytocin levels increased (Blume et al., 2008).

Genetic selection and domestication processes

Selection against aggression in mammals shows multiple equal effects in all domestic species concerning their morphology, behaviour, physiology and psychology, which is known as domestication syndrome (Hare et al., 2012). In domesticated species, the characteristic less aggressive and less fearful behaviour in combination with increased pro-social behaviour is accompanied by face shortening, reduced cranial capacity, reduced tooth-size, partial depigmentation, floppy ears and increased fertility (Trut et al., 2009). It is suggested that the domestication syndrome results from mild neural crest cell deficits during embryonic development where migration defects are particularly important (Wilkins et al., 2014). Neural crest cells arise from the neural tube shortly after its closing and they migrate throughout embryonic tissue where they differentiate into most of the peripheral nervous system as well as the facial skeleton and pigment cells. No genetic evidence indicates that the changes seen in domesticated animals are the result of single mutations (Wilkins et al., 2014). Polygenetic causation is suspected as a responsible mechanism. In addition the symptoms of domestication syndrome occur very rapidly.

The most well-known experiment concerning to canid domestication is the Siberian farm-fox-experiment with Siberian silver foxes (Balyaev, 1979). Having minimum but daily contact to humans, only low aggressive individuals at the age of seven month were chosen for further breeding. The control line was reared under identical conditions avoiding minimum daily contact to humans, and individuals were bred randomly. Within twenty to forty generations in the experimental group numerous features of domestication syndrome were observed. First, physiological changes including changes in the adrenal cortex, serotonergic and limbic systems related to a down regulation of the hypothalamic-pituitary-adrenal(HPA)axis, were identified. The brains of experimentally domesticated foxes exhibit elevated levels of serotonin and tryptophan hydroxylase relative to unselected control line (Popova et al., 1980; Kulikova et al., 1989; Ham-

mer et al., 1992; Trut, 1999). Cortisol levels in domesticated foxes were also lower. They had less corticosteroid reactivity and changes in gene expression in the HPAaxis (Plyusina et al., 1991; Gulevich et al., 2004; Trut et al., 2009) compared to control group foxes. Second, individuals of the experimental fox population showed behavioural changes like tail wagging, submissive posturing and barking. Third, individuals of the experimental fox group showed morphological changes include floppy ears, piebald coats, curly and shortened tails (Trut, 1999). Fourth, cognitive changes in social problem solving skills improved in foxes of the experimental group (Miklosi et al., 2003; Hare et al., 2005). Finally, compared to control group individuals, spontaneous ability to use basic human communicative gestures had improved in experimental group foxes. Domesticated fox puppies were as skilled as dog puppies in using human communicative gestures (Hare et al., 2005).

It is commonly accepted that genetic polymorphism can modulate the function of evolutionary conserved complex mammalian brain systems like oxytocin system and serotonin system. Oxytocin is well known for its role in mammalian bonding (Lim & Young, 2006). Single nucleotide polymorphism (SNP) in oxytocin receptor gene in brain as well as in serotonin transporter (SERT) gene are known in humans, wolves and dogs (Kumsta et al., 2013; Kis et al., 2014; Oliva et al., 2016). Humans with SNPs in oxytocin receptor gene with homozygotes G allele are more social and friendly in general relationships, but they show no difference in closed relationship (Li et al., 2015). Dogs carrying G allele show lower proximity seeking (Kis et al., 2014; Oliva et al., 2016). Serotonin transporter 5-HTTLPR homozygotes L allele is associated with lower anxiety symptoms (Hariri, 2002). However, there might be many other unknown genetic variations influencing social behaviour. Gene expression changes in brains of domestic dogs compared to wild wolves are confirmed (Seatre et al., 2004; Axelsson et al., 2013). As a form of natural genetic selection and the first step of dogs' "self-domestication", we assume that less aggressive and less fearful ancient wolves had been the ones becoming more confident to humans (Hare et al., 2012). These less aggressive wolves gained a selective advantage because they were able to come into contact with humans more easily, eventually sharing hunting success (Thalman et al., 2013; Shipman, 2015). These human associated wolf clans formed behavioural cultures leading to genetic isolation (Wayne, 2014; Foote et al., 2016; Filatova et al., 2015). Coming into contact with humans, natural selection in wolves had played an important role long before intentional breeding by humans occurred (Hare et al., 2012).

Epigenetic Modulation of the HPAaxis

Genetic selection is a necessary prediction but not a sufficient explanation for domestication from wolf to dog. Concerning to the farm-fox experiment (Trut et al., 2009) first changes in experimental group foxes were seen in down regulation of the HPAaxis within a few generations. Therefore we consider that this results give evidence that domestication process is not only caused by genetic selection but also by epigenetic modulation of the HPAaxis.

Domestication means decreased flight distance and decreased sensory threshold chiefly concerning to humans causing less aggressive and less fearful behaviour (Benecke, 1994; Hare et al., 2012). Hence we have to work on the HPAaxis during domestication processes. We consider domestication is essentially an epigenetic based process of changing the interactions of the HPAaxis and the 5-hydroxytryptamine (5-HT) system.

The limbic brain regions such as hippocampus, amygdala and cingulate cortex play a key role in mood control (Kirsch et al., 2005; Kienast et al., 2008; Kosfeld & Fehr, 2005). They are sensitive to glucocorticoids and innerved by serotonergic projections. The activity of the HPAaxis is influenced thru an enhancement of the corpus amygdala and an inhibition thru the hippocampus. Hippocampal glucocorticoid receptor (hGCR) density is likely to affect its inhibitory effect on

this system. Epigenetic input like DNA methylation is known to impact the regulation of hGCR expression (Buschdorf & Meaney, 2015). The HPAaxis and the 5-HT system are closely cross-regulated under physiological conditions (Lanfumeu et al., 2008). If stress and therefore cortisol levels decrease, serotonin levels increase. And vice versa, increased serotonin levels leads to decreased cortisol levels. Lower cortisol and higher serotonin levels in brain promote pro-social behaviour, juvenilized social behaviour and learning ability whereas aggressive behaviour decreases (Murrin et al., 2007; Niehoff, 1999). Thus, changes in the interactions of the HPAaxis and the 5-HTsystem are of particular relevance when regarding the domestication processes of animals.

Deriving the hypothesis of the Active Social Domestication (ASD)

Experimental group foxes of the farm fox experiment first show changes in their adrenal cortex, serotonergic and limbic systems, which are related to a down regulation of the HPAaxis within only a few generations. The brains of experimentally domesticated foxes exhibit elevated levels of serotonin and tryptophan hydroxylase relative to unselected control line (Popova et al., 1980; Kulikova et al., 1989; Hammer et al., 1992; Trut, 1999). Cortisol levels in domesticated foxes were also lower. They had less corticosteroid reactivity and changes in gene expression in the HPAaxis (Plyusina et al., 1991; Gulevich et al., 2004; Trut et al., 2009) compared to control group foxes. These results are corresponding to epigenetic modulation of the HPAaxis due to social affection (Meaney & Szyf, 2005; Buschdorf & Meaney, 2015). We hypothesise that epigenetic modulation of the HPAaxis might be an important mechanism contributing to domestication and domestication syndrome. There is evidence in humans and rodents that parental care in form of social affection can affect endocrine and autonomic response to stress that endure into adulthood (Meaney & Szyf, 2005). Predictably, adult offspring of rat mothers, which showed increased pup licking and grooming (LG+), is less fearful. This offspring is equipped with significant increased hippocampal glucocorticoid receptor (hGCR) expression, enhancing glucocorticoid negative feedback sensitivity and decreasing corticotropin-releasing factor (CRF) levels. Whereas the offspring of stressed low licking rat mothers (LG-) is more fearful, showing decreased hGCR expression with high CRF levels. Cross-fostering the biological offspring of LG+ and LG- mothers reverses the phenotype, suggesting a direct relationship between variations in maternal care and development of the HPAaxis responses to stress. Stress responses in the adult rat are programmed early in life by maternal care and are associated with epigenomic marking (DNA methylation) of the hGCR 1,7 promotor. Even in human brains, a meaningful relationship between childhood abuse and epigenomic marking of the hGCR 1,7 promotor has been identified (McGowan et al., 2009). Due to evolutionary continuity of brains, the HPAaxis is established for millions of years (LeDoux, 2012) in the same function, therefore it is legal to predict explained epigenetic modulation of the HPAaxis in rodents (Meaney & Szyf, 2005) and humans (McGowan et al., 2009) as well as in wolves and in dogs.

Factors identified include down-regulation of hGCR expression by enhanced methylation of GCRexon1;7promotorbloc because of decreased social affection (McGowan et al., 2009). Social factors like licking and grooming enhance hGCR expression via increased serotonin, and subsequently increased NGF levels binding on GCRexon1; 7promotorbloc causing DNA demethylation. GCR density and thereby activity of the HPAaxis is determined in childhood (Meaney & Szyf, 2005). Low stress environment generates less stressed individuals, therefore maternal care improves. Due to the epigenetic modulation of the HPAaxis, the offspring of those less stressed mothers is again less fearful and less aggressive, in turn exposing improved maternal care. Cortisol levels decrease while cross regulated neurotransmitters and neuropeptides like serotonin and oxytocin increase. Epigenetic modulation of the HPAaxis leads to lower cortisol levels and might therefore also cause mild neural crest cell migration deficiency during embryonic devel-

opment. Cortisol can cross the placenta, thus lower cortisol levels and higher serotonin levels of less fearful mothers might influence epigenetic modulation in embryonic development especially due to embryonic brain development (Ahmed et al., 2014; Trut et al., 2009). Further research is required and might give more information.

Because of this epigenetic modulation, individuals become less aggressive and less fearful, trust and in-group behaviour increase due to oxytocin effects (Kirsch et al., 2005; Kosfeld/Fehr, 2005). In the Paleolithic period individuals of wolf clans associated to human hunter-gatherers were less stressed because they were used to human presence and gained an evolutionary benefit (Thalman et al., 2013; Shipman, 2015). Hence from generation to generation epigenetic modulation of the HPAaxis decreased stress levels of human associated wolves more and more, and eventually the wild wolf became a tame wolf. But a tame wolf is not even a dog.

Nowadays it is commonly accepted that high cortisol levels inhibit the activity of prefrontal cortex and neural structures which are important for learning (Arai et al., 2009). Furthermore, the activity of the prefrontal cortex also plays an important role in glucocorticoid feedback inhibition of the HPAaxis. Low cortisol levels promote the function of the prefrontal cortex contributing to better executive function capability including better cognitive inhibition and improved social learning capability (McKlveen et al., 2013). Therefore, we suggest due to the hypothesis of the Active Social Domestication (ASD) that epigenetically decreased cortisol levels and increased serotonin levels enabled tamed and less fearful wolves a closer association to humans and better understanding of human social gestures. Emotional and cognitive empathy of tamed wolves could increase concerning to humans. The tame wolf became able to grow into a domesticated social dog capable of working together with humans in an active form of partnership. Dogs have learned to use human communicative and pointing gestures, and also developed complex human-analogue social behaviour (Marshall-Pescini et al., 2012; 2014). Compared to wolves, dogs possess a higher level of inhibitory control concerning to humans (Marshall-Pescini et al., 2015). Thus, this alliance of two predator species allowed them an unprecedented degree of hunting success during the Palaeolithic period and made it the first big evolutionary benefit of human-dog partnership (Shipman, 2015). Later on, dogs helped humans transporting materials, even tending their sheep and goats. Eventually wolf dogs integrated themselves in human social structures. Accepting humans as their preferred social binding partner (Range et al., 2013) tame wolf dogs became domestic dogs.

Summary

In addition to natural genetic selection, the hypothesis of Active Social Domestication from wolf to dog posits epigenetic modulation of HPAaxis caused by increased interspecific social affection (Meaney & Szyf, 2005; McGowan et al., 2009) as an important mechanism in the domestication process. We proclaim that sharing an identical ecological niche, wolves' and humans' similar social behaviour and cooperative hunting patterns (Shipman, 2015) enabled them interspecific communication due to the evolutionary continuity of their mammalian brains (Ledoux, 2012; Gimpl & Fahrenholz, 2001; Reep et al., 2007; Ferrari, 2016). Wolves with genetically disposed friendly behaviour and less fear are supposed to get in closer contact to human hunter-gatherers (Hare et al., 2012) during a cooperative hunt or while lingering near by the prey. Thus, interspecific interactions could improve. Being able to understand interspecifically the gestures of each other, individual bonding between wolves and humans could start (Range et al., 2014). Human associated wolves and human hunter-gatherers became familiar, behavioural cultures were formed (Wayne, 2014; Foote et al., 2016; Filatova et al., 2015; Avital & Jablonka, 2000) and genetic isolation of human associated wolf clan began (Wayne, 2014). Mutual empathy is assumed to have improved and thus, stress decreased. This means that epigenetic modulation via increased hGCR

expression reduced the activity of the HPAaxis, maternal care and social affection could improve. Low cortisol levels increased the release of serotonin and oxytocin leading to a further grow of pro-social behaviour as well as social learning abilities (Beetz et al., 2012). Individual bonding between wolves and humans improved enhancing interspecific in-group behaviour related to both specimen. Thus, wild wolves became tame wolves. From generation to generation improved social learning abilities and increased inhibiting effect of the prefrontal cortex facilitated the domestication of tame wolves to domesticated dogs due to described epigenetic modulation of HPAaxis. Dogs are able to work together with humans in an active form of partnership. Dogs are integrated in human social structure. Dogs even prefer human bonding partners (Range et al., 2013).

Epigenetic modulation of the HPAaxis due to social affection has had an effect probably not only in wolves and dogs but also in humans. Today, social interactions between humans and dogs still reduce the activity of HPAaxis in both species and improve pro-social behaviour via increased oxytocin release (Beetz et al., 2012) as explained in the hypothesis of Active Social Domestication. Reducing stress as well as invigorating social learning abilities is known to be the reason of the benefit of dog facilitated therapy in medical and social treatment (Julius et al., 2014). Therefore humans' social and learning abilities are supposed to have improved during the Paleolithic period, too.

Discussion

Although the concept of the Active Social Domestication from wolf to dog is at present only a hypothesis, many scientific results do support it. We proclaim that epigenetic modulation of HPAaxis tries to fill the gap between natural selection and intentional breeding in dogs' domestication as a kind of self-domestication process. It has been proven that wolves and humans shared identical ecological niche and expressed same social and hunting behaviour (Mech, 1999; 2009). Shipman (2015) and Thalmann et al. (2013) described ancient interactions of humans and wolf-dogs when dogs were domesticated 18.800 - 32.100 years ago. The oxytocin and serotonin system as well as the HPAaxis are evolutionary conserved, both the hormones and their receptors are present in all mammal taxa (Ledoux, 2012; Gimpl & Fahrenholz, 2001). Furthermore evidence is provided that genetic variants of genes important for brain function (Axelsson et al., 2013) including mutations of the oxytocin gene may have played a role in the first step of natural selection from wolf to dog (Oliva et al., 2016; Hare et al., 2012). However, genetic polymorphisms and epigenetic mechanisms modulate the functions of complex brain systems in both species (Oliva et al., 2016; Meaney & Szyf, 2005). Epigenetic studies indicate that a less stress environment and higher social affection decrease cortisol levels via increased hGCR expression while increasing serotonin and oxytocin levels. Maternal care improves and thus the offspring shows less fearful and less aggressive behaviour (Meaney & Szyf, 2005; Mc Gowan et al., 2009). We suspect that these epigenetic mechanisms as well as natural genetic selection enabled wolves to grow into domestic dogs. During cohabitation of humans and their associated wolf clans, human-like social skills of first wolf-dogs emerged, such as following human referential gestures (Range & Viranyi, 2013), joint attention (Gamer et al., 2010; Nagasawa et al., 2015) and attachment to human owners (Prato-Previde et al., 2003). Until today, human-dog bonding decreases cortisol levels and increases oxytocin and serotonin levels in both species (Beetz et al., 2012).

The farm-fox experiment (Trut et al., 2009) is the most important experimental research supporting the hypothesis of the Active Social Domestication. Domestication syndrome occurs within a short period of only twenty generations. First, changes of experimental group foxes with little daily contact to humans were found in the HPAaxis, serotonin and oxytocin systems. This appears compatible to epigenetic modulations due to social affection. Later on, changes were identified concerning behavioural changes, than morphological changes and, even later

on, changes in social problem solving. Domesticated fox puppies were as skilled as dog puppies in using human communicative gestures (Hare et al., 2005). Therefore, we consider these results as evidence that domestication process is not only caused by genetic selection, but also initiated by epigenetic changes of the HPAaxis. Stray dogs, not used to human presents in their critical period, 3-10 weeks of age, often show fear of humans which may override dog's cognitive capacity to use humans' social cues (Udell et al., 2010; Range & Viranyi, 2013). This may support the importance of epigenetic mechanisms in domestication processes.

Most of the previous theories assume intentional breeding by humans as the main mechanism of the domestication from wolf to dog (Lorenz, 1967; Zimen, 1992). But intentional breeding of wild wolves could not have been possible for humans living as hunter-gatherers 25.000 years ago without chains of steel or stables made of stone. Therefore, genetic selection caused by intentional breeding cannot be the main reason for initiating the first step of domestication from wolf to dog although it surely played an important role in further breeding of pedigree dogs. Contemporary theories of dog's domestication favour self-domestication processes (Coppinger, 2001; Morey, 1994; Hare et al., 2012). Beside natural selection we hypothesize epigenetic modulation of HPAaxis to play a key role in self-domestication processes, not only in dogs, but even in the domestication of other mammals and in human cultural evolution as well (Hare et al., 2012). Within a narrow time frame of dogs' domestication, archaeologists described a sudden further stage of human cultural development (Gamble et al., 2015). In the Aurignacien (approx. 35.000 - 26.000 years ago) first flutes, sculptures, cave paintings and javelin spins occurred. Modern humans started living in larger social groups, held together by their increased cultural practice. Even other mammals are known to live in larger groups due to inhabiting ecological niches with low stress factors. Florida Key deer (*Odocoileus virginianus clavium*) has increasingly encroached urban areas over the last 30 years showing higher body mass, higher fitness and they are living in larger social groups compared to those living farther away from urban areas (Harveson et al., 2007). Island vertebrates are known to be less aggressive and they are often living in larger social groups (Adler/Levins, 1994; Gray & Hurst, 1998). Darimont et al. (2014) describe low aggressive behaviour of island wolves consistent with a dietary niche. Diet is also known to effect epigenetic gene regulation of HPAaxis (Waterland & Jirtle, 2003). Therefore it is reasonable to discuss diet as an additional factor influencing domestication processes, especially concerning to a further stage of dog domestication when settlement and farming started in the Neolithic period. Then humans and their dogs started adaptation to starch-rich diet (Axelsson et al., 2013), thus tryptophane levels in brain increased leading to reduced aggression and better pro-social behaviour (Fernstrom & Wurtman, 1971; Chamberlain et al., 1987; Waterland & Jirtle, 2003).

Future research might strengthen the hypothesis of the Active Social Domestication while analysing cerebral methylation patterns in wolves and domestic dogs, most likely by comparing wild wolves versus human hand reared wolves as well as pet dogs versus stray dogs. Further research in neural crest cell migration deficits during embryonic development might also give evidence concerning epigenetic modulation due to cortisol levels. The main difficulty of the hypothesis of the Active Social Domestication is that dog domestication could not be repeated experimentally in the same way it happened.

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Daniela Pörtl and Christoph Jung contributed equally to this work

Correspondence and requests for materials should be addressed to Daniela Poertl
Obschuetzerstrasse 17. D-06667 Weissenfels-. Germany
Email: d.poertl@t-online.de. Phone +49 3443 2947533. Fax +49 321 21206281

La domesticazione del cane è dovuta ad una modulazione epigenetica nel cervello?

Daniela Pörtl¹, Christoph Jung²

¹ *Dipartimento di Psichiatria, Ospedale didattico di Leipzig
Università di Jena, Naumburg, Germania*

² *Psicologo*

Sintesi

I cani (*Canis lupus familiaris*), sono considerati i primi animali ad essere stati addomesticati e vivono con l'uomo da almeno 25 mila anni. Oggi i ricercatori sostengono che la domesticazione sia da considerarsi un processo di auto-addomesticazione ma non è ancora chiaro come sia avvenuta. Durante il Paleolitico, uomini e lupi vivevano in famiglie strutturate come clan di cacciatori cooperativi, nella stessa nicchia ecologica. La continuità evolutiva che esiste tra i cervelli dei mammiferi ha reso possibile la comunicazione interspecifica e l'interazione sociale tra uomini e lupi, riducendo lo stress e l'aggressività durante i frequenti contatti tra le due specie e costituendo il primo passo di un processo di domesticazione naturale. La domesticazione implica una diminuzione dell'aggressività ed una riduzione della distanza di fuga dall'essere umano. Per questo motivo, cambiamenti nell'attività dell'asse Ipotalamo-Ipofisi-Surrene (HPA) sono ritenuti essere molto importanti durante il processo di domesticazione del lupo che lo ha trasformato in cane.

L'ipotesi di una domesticazione sociale attiva considera la selezione genetica come un fattore predittivo ma non sufficiente per spiegare la domesticazione del cane. Inoltre si ritiene che la domesticazione del cane sia basata essenzialmente su un processo epigenetico che cambia le interazioni dell'asse HPA e del sistema serotoninergico.

Le regioni limbiche dell'encefalo, come l'ippocampo e l'amigdala, giocano un ruolo chiave nel controllo dell'umore. Esse sono sensibili ai glicocorticoidi e innervate da proiezioni neuronali serotoninergiche. L'asse HPA e il sistema serotoninergico sono strettamente interconnessi in condizioni fisiologiche. L'attività dell'asse HPA è influenzata da stimolazioni provenienti dal corpo dell'amigdala ed inibita dall'ippocampo. La densità dei recettori ippocampali di glicocorticoidi regola, verosimilmente, l'effetto inibitorio sul sistema.

Il comportamento pro-sociale stimola, epigeneticamente, l'espressione dei recettori ippocampali di glicocorticoidi in seguito ad un aumento della serotonina e conseguentemente si assiste ad un aumento del fattore di crescita del nervo, che si lega al GRexon1; 7, inducendo la sua demetilazione e quindi portando ad una riduzione dei livelli di cortisolo.

Ridotti livelli di cortisolo aumentano le capacità di apprendimento sociale e promuovono l'attività della corteccia prefrontale, migliorando le capacità operative e l'inibizione cognitiva. Perciò i ridotti livelli di cortisolo in famiglie di lupi meno stressate dalla presenza dell'uomo, hanno permesso loro di migliorare le capacità sociali nei confronti dell'essere umano. Col tempo questi lupi ammansiti sarebbero potuti trasformarsi in cani, in grado di mostrare comportamenti centripeti nei confronti delle persone.

A case of coprophagy and pica in a geriatric epileptic dog

Sara Enrico*

Veterinary surgeon - AVSE - AMBULATORIO VETERINARIO - Turin (Italy)

Abstract: A geriatric dog, treated for epilepsy since the age of 3 years, developed a marked allo-coprophagic behavior and several episodes of pica. Multifactorial causes were taken into exam in the evaluation of the behavior: patient's history, pharmacologic treatments and the consequent liver dysfunction, age related problems and underlying motivation. A protocol of behavioral modification, essentially based on a counterconditioning model, was put in place to reduce the behavior and the related health risks.

Key Words: coprophagy, pica, epilepsy, hepatic dysfunction, dog.

* *Corresponding Author:* xaralula@gmail.com

Presentation

A dog, treated for idiopathic epilepsy, was evaluated for an increased coprophagic behavior and, to a lesser extent, for pica. The patient is a 12 years and 7 months, 16.6 kg, neutered female, mongrel dog.

History and presenting signs

The patient was found, on the day of her birth in a garbage bin closed in a bag with her newborn sister. It was summertime and, when the puppies arrived at the clinic they presented signs of heat stroke ($T^{\circ} > 41^{\circ}\text{C}$) and hypotensive shock. After a period of intensive care, during which the two dogs had a long sequel of health problems, they were adopted by the veterinarian of the clinic. They were submitted to artificial nutrition until weaning; everyday they met two adult female dogs to allow them to develop a normal intraspecific relationship. When the puppies were 4 months old, they were involved in a training as rescue dogs.

A brother of the same litter, after some negative experiences of adoption and a period of six months spent in a shelter, was adopted by the owner of the two sisters. The male dog was affected by sensory deprivation syndrome type I, showing redirected and intraspecific aggressions, hyperactivity and lack of self-control. Although he was treated with fluoxetine and with a specific behavioral modification training program, he never had a complete remission from his behavioral problems. When he arrived in the new home, he presented house soiling for a long time. Because he repeatedly attempted to pair with the sisters, although he was neutered, the owner decided to spay also the two female dogs, when they were 3 years old.

Few months after the neutering, the patient had the first seizure and, after some episodes, she was treated with phenobarbital. In the same way, the sister had her first seizure less than 7

months later. Both the sisters presented cluster crises with tonic-clonic convulsions, lasting 72 hours and repeated every 2-3 weeks. After the crisis, both the sisters had a post-ictal phase characterized by tremors, movement incoordination, ataxia, falling downs, lasting almost a week.

The diagnosis, made by the neurologist, was idiopathic epilepsy and the dogs, due to the ineffectiveness of monotherapy, started the protocol with the association of phenobarbital and potassium bromide but with no positive results. During this period both dogs began to show house soiling and consumption of feces and everything else accidentally found in the environment. While the patient has never shown auto-coprophy, the sister often tried to eat her own feces during and after defecation.

The sister, when was 5 1/2 years, died during a seizure, twelve hours after a surgery to solve an intestinal intussusception, occurred after the ingestion of part of a mattress padding and of a plastic bag with some dry food for cats inside.

The activities of the three dogs during their cohabitation had a consistent pattern: long daily walks on leash, weekly excursions to the mountains and training sessions. The dogs were gradually used to the muzzle and this habit was maintained after the death of the sister.

Between 7 and 8 years of age, the patient presented three severe episodes of pica: she drank 2.5 l of red wine, 600 hg of mayonnaise sauce and a leather leash with several knots. After the ingestion of mayonnaise, she developed an acute pancreatitis. Several months were necessary to have a complete recovery of the patient from pancreatitis but since that moment the dog hasn't had seizures anymore.

The resistance of the epilepsy to the therapies led to the change of the protocol and, some time before pancreatitis, potassium bromide was substituted by Gabapentin.

During the following two years, the activities of the dogs were reduced because of the owner's disease; at the end of this period, the brother was adopted by the mother of the owner.

Now, the patient lives with the owner in a little apartment at the 4th floor of a building in a metropolitan area. In the house, there are no other animals but the dog grew up with some cats that she meets every week when she visits her brother. When she has the opportunity, she steals cat food and feces from the cat litters.

The dog is fed two main meals, at 7.00 am and 7.00 pm, composed by industrial dried food, and other two small meals during the day. She demonstrates good self-control during meal preparation but she is always very hungry and she anticipates the moment with yapping barks.

During the day, the dog often obtains several treats as a reward. She doesn't ask for food during family meals and she doesn't receive food from the table. Water consumption is normal.

The dog is regularly taken out for walks but she doesn't have a strict routine. Walks usually have a length of 3 to 12 km, divided into 4 outputs of varying duration, between half an hour and a few hours. The destinations are parks and green areas of the town and dogs-area in which the dog is free to walk and run. Intra and interspecific relationships are good and play behavior is particularly oriented to food-reward games.

Eliminations are normal and her exploratory behavior and territorial marking are adequate. She does not eat her feces. During the last year she has shown some rare episodes of inappropriate urination in strangers' houses and few episodes of incontinence, generally on beds and during the night.

The sleeping schedule is normal. She wakes up early in the morning asking for food but she sleeps all night. She sleeps with the owner in her bed during the night and on sofas in the veterinary clinic of the owner or at home daytime.

The patient is afraid of strong acoustic stimuli such as thunder, fireworks, shots, train or bus whistles. She reacts with trembling, freezing and looking for a secure place (near the owner or on the sofa if at home). She quickly returns to homeostasis, when the stimulus ends, and she has never shown any symptoms of generalization. In a new situation, she reacts by observing people, animals and the environment without showing signs of stress but avoiding any interaction.

She is afraid of the clinical examinations carried out by unknown veterinary surgeons. She does not like excessive physical contact but she tolerates it passively.

Physical and laboratory evaluation

At clinical examination, the patient presents good nutrition condition (BCS 5/9) and hydration in the standard range. Heart and respiratory rates are normal. Abdomen is palpable and not sorrowful. No episodes of vomiting and diarrhoea have been reported in the last months. There are no signs of neurological illness or visual/acoustic impairment. The dog has normal responses to acoustic and tactile stimuli, she is alert, attentive and collaborative although somewhat intimidated by manipulations. There are no algic responses to column palpation, musculo-skeletal pain in other districts nor joint pain.

On the body there are some subcutaneous neoformations identified as lipomas by previous cytological examinations. On the left paw there are two benign neoformations that periodically the dog chews, inducing a secondary infection recently treated with antibiotics. If recalled, the dog stops immediately chewing the lesions and the behavior does not assume repetitive characteristics.

At the end of 2015, during a routine check-up, the patient showed increased hepatic enzymes values and, at ultrasound echographic examination, a diffuse parenchymal disomogeneity of liver and a nodular lesion emerged. No more diagnostic examinations were performed. After a year, the hepatic lesion presented a double size (1.4 cm). There were several hyperechoic focal lesions with well-defined merges and the hepatic parenchyma presented a pattern with diffuse disomogeneity probably consequence of chronic assumption of barbiturates. At the moment the dog assumes fenobarbital 65 mg bid os (3.91 mg/kg bid) and gabapentin 300 mg bid os (18 mg/kg bid). Every 3-4 months a treatment with a hepato-protector containing silymarin and MOS is performed. The values of ALT, AST, γ GT, BUN, total bilirubin, albumin, fasting and post-prandial bile acids were normal at the last hematologic and biochemical tests as well as all other values. Urine and feces examination did not present alterations.

Behavior evaluation

Coprophagy shown by the patient is typically allo-coprophagy: she eats faeces of other dogs/animals but she did not eat her own nor the brother's feces when they went out together for walks. The behavior is shown both in presence and in absence of the family and other dogs, at home (cat feces) and outdoor, when she is free or on the leash, regardless of the state of gastric repletion. The dog does not show particular preference for the kind of feces she consumes: consistency, volume, temperature don't make a difference. If not scolded, she consumes them without hurry, tasting them.

Pica was no longer performed at home in the last period but is shown outdoors where the patient frequently consumes chewing gums. She does not eat grass, but she eats little woods. The exploratory behavior is finalised to find if something to eat and when it is found she seems to be satisfied but further researches are not inhibited.

The main objective of the dog is to find and eat feces. She looks for them and knows the places where they are. If on the leash, she pulls it on trying to arrive to her target as soon as possible; if let free she doesn't listen to the call until all the feces or everything else found are consumed.

The owner, to contrast the dog behavior, tries to anticipate it changing way, pulling the dog away from feces or calling her during the ingestion attempts. This seems to increase the dog's frustration taking into consideration the motivation: organic reasons add up the real pleasure of

ingestion. When the behavior is interrupted, the dog memorize the place where feces are and in a second moment tries to eat them without fail.

In consideration of the age, the patient was checked for cognitive dysfunction on the basis of Landsberg's checklist that takes into account the DISHA aging signals (disorientation, interactions, sleep, house soiling, activity) (Landsberg et al., 2013). The score was 2, due to the slight increasing of fear of auditory stimuli and sporadic episodes of urinary incontinence. Even EVEC (Colangeli & Giussani, 2004) or ARCAD classification for the evaluation of the emotional/affective and cognitive age-related disorders had a normal score: 9. The dog seems to present a normal aging with a tendency to show repetitive behaviors.

Diagnosis

The time of onset of coprophagy and pica let consider a direct consequence of the epilepsy and the treatments adopted (Landsberg et al., 2013). Hyperphagia and polyphagia shown by the dog after seizures, the constant assumption of barbiturates and the never-ending sensation of hunger induced by the therapy contribute to increasing the dog motivation. In human medicine, a recent study includes epilepsy in the spectrum of psychiatric and neurological disorders associated to coprophagy (Josephs et al., 2016).

Acute pancreatitis was not followed by a compromission of the organ so severe as to determine a pancreatic insufficiency with consequential maldigestion and malabsorption. Furthermore, in this case, the dog could show autocoprophagy too, because of the great intake of organic elements and nutrients which had not been digested, still present in her own feces (Beaver, 2009) but this aspect is not present in our case and previous examination (TLI, fecal chymotrypsin) do not support this diagnostic hypothesis. Again, according to Beaver, coprophagy in adult dogs seems to be more common among subjects who practice little exercise or are confined into limited spaces. These features do not correspond to the case and are not comforted by subsequent studies that do not find correlation between physical activity (defective or excessive) of the dog and predisposition to coprophagy (Boze, 2010) and not even between boredom and coprophagy (Boze, 2008). This aspect is curious because environmental enrichment and improvement of the relationship with the owner are among the most effective remedies in treating the disease (Boze, 2008).

Vitamin deficiencies have also been considered as causes of coprophagy. Especially the thiamine deficiency, vitamin B1, water-soluble, thermolabile, among other symptoms, induces coprophagy (Fascetti & Delaney, 2012). However, a dog fed with industrial dry food (added with thiamine after the extrusion process) can hardly develop a vitamin B1 depletion but can be manifested in animals fed for long periods with raw fish (carp, herring) containing thiaminase (Case, 2011).

In a study based on survey compilation, 632 dog's owners answers were analysed to find a correlation between coprophagy and individual factors (sex, age, sterilization, weight, activity), environmental factors (interaction with the owner, play and physical activity, opportunity to find feces), care and nutritional factors (common disorders, vaccinations, type of feeding and frequency of meal administration) and behavior factors (presence/absence of coprophagy, owner reactions, characteristic of coprophagy,) the relationship between anxiety disorders and pica/allocoprophagy was statistically significant (Boze, 2010), but causes of anxiety of coprophagic dogs are unknown.

Patient's liver dysfunction was subsequent to coprophagy. However it may justify its accentuation coming under the digestive disorders that Boze believes to have statistically significant correlation in coprophagic dogs.

It is reasonable to think that in this case coprophagy is multifactorial and that a tendency to

repetition exasperates the behavior. The owner's greater attention to the dog, probably due to the absence of her brother during walks, tends to reinforce the behavior.

Treatment

To be able to verify the efficacy of treatments a 5 minutes video in which the dog was let free in a fenced space was performed. During this time she found and ate three stools of other dogs. This will serve as a comparison to evaluate whether or not treatment is effective, as suggested in human studies conducted on psychiatric patients. (Fox & Martin, 1975).

A vitamins B complex was added to patient's diet, despite vitamins depletion is a remote hypothesis in our case. Anyway, in human medicine, depletion of riboflavin has been reported in epileptic patients treated with phenobarbital (Merck's Manual) and, in veterinary and human medicine, a lack of vitamin D3 (Gascon-Barré et al., 1986; Teagarden et al., 2014), folic acid and cyanocobalamine (Pulido Fontes et al., 2016) has been reported with a statistically significant difference in patients pharmacoresistant to classical antiepileptic drugs. Furthermore, consumption of ungulates feces has been linked to the need for group B water soluble vitamins in dogs (Lindsay, 2005; Overall, 1997).

The routine of meals was slightly changed. The small morning meal was replaced with an activation game (ball with croquettes inside) that entertains the dog for 45 minutes and a Kong with jerky meat inside was added in the afternoon. This was to reduce the feeling of hunger as much as possible and keep the dog focused on stimulating and fulfilling activities.

Desensibilization is not a reasonable target because the dog can find feces everywhere outdoors. This aspect represents a negative prognostic factor in the resolution of behavioral problem. Anyway, to reduce the exposition to stimuli, it was decided to avoid free walkings in parks or dogs areas for at least a couple of months.

Training of "leave it" command was gradually proposed using the Landsberg's method (Landsberg et al., 2013): in a first stage a treat is held in the closed hand and when the dog spontaneously stops trying to open the fist and focuses attention on the owner is rewarded and praised. Then the command "leave it" is added to the sequence. When the dog is sufficiently trained (the waiting time progressively stretches), the treat is offered on the open hand and finally the training is generalized with objects, before a little and then of increasing interest, on the ground. Every time the dog is rewarded with delicacies. When the dog is interested in outdoor feces, the owner does not recall her but maintains an adequate leash tension to avoid the consumption. When the dog spontaneously turns her attention to the owner and behaves differently (eg sitting) she is praised with a "good girl!" and immediately rewarded with a treat (Case, 2010). In the same way the dog is praised when spontaneously ignores feces outdoors and when at home she does not show interest for cat's litter. Efforts have been made to choose counterconditioning techniques that induce the least possible frustration in the dog, considering the age and motivation that push the dog to consume feces (hunger).

The use of various types of repellent (eg tabasco, pepper etc) placed on the stools or inoculated inside has not been taken into account because it is technically unenforceable and in any case of dubious efficacy. Even the administration of supplements that make stomach odor or alter feces consistency (Forbid, broken mints, monosodium glutamate, sulfur, papain, iron sulphate, fiber – broccoli, carrots) has not been taken into account because the patient does not show autocoprophagy (Landsberg et al., 2013).

The use of punitive or aversive techniques, although proposed in some texts (Lindsay, 2005), was not considered because ethically unacceptable, dangerous and counterproductive. In a study by questionnaire distribution to owners of 632 dogs, 49% of whom showed coprophagy

and 28% of them showed behavior more than once a month, emerges that the most effective treatment in coprophagy prevention is to establish a solid dog-owner relationship. Prevent access to the stools, strengthen correct behaviors, and distract the animal from stools seem to be the best treatments. While punishment (positive or negative) was ineffective in the prevention of coprophagy (Boze, 2008). In human medicine behavioral modification techniques in coprophagic subjects were found to be ineffective. Best results were obtained with pharmacological therapy (haloperidol) (Josephs et al., 2016). Especially in presence of autocoprophagy, Karen Overall also suggests pharmacological intervention in dogs that exhibit anxiety-related or compulsive behavioral disorders (Overall, 1997).

Follow up

After a month of treatment, group B vitamins integration was suspended because no significant improvements were noticed.

After 5 months of training the dog spontaneously turns the head towards the owner in presence of feces outdoor or sit in front of her waiting for a reward. This behavior is not performed every time, but the consumption of feces has been reduced by about 50%.

At home the dog is increasingly reporting the presence of cats' feces sniffing the air and sucking but avoiding the temptation to go and consume them.

No new attempt to leave the dog free was performed.

Discussion and conclusions

Coprophagy is a normal behavior in puppies and bitches that try to clean the nest of their litter (Gazzano, 2013). If it persists in adult subjects, it can represent a serious problem in relationship between dog and owner and undermines their bond until it brings, in extreme cases, to take into account euthanasia. (McKeown et al., 1988). It represents a potential health risk for the dog that is not only exposed to parasitism and infectious diseases but also to poisoning. Dogs frequently assume therapies for several pathologies and their active metabolites (hormones, chemotherapeutic agents, NSAIDs, etc.) can be ingested with feces. A case of thyrotoxicosis has been reported in a dog consequent to regular intake of stools of the cohabiting dog treated for hypothyroidism (Shadwick et al., 2013) and a case of carprofen intoxication due to consumption of feces of the mate-dog in prolonged NSAID therapy (Hutchins et al., 2013).

Coprophagy often has a multifactorial etiology that touches different spheres of medicine, as in the case reported. It is therefore important to try to understand what motivation prevails in the behavioral expression in order to effect the most appropriate therapies for the specific case, combining eventually different methods and approaches (Bowen & Heath, 2005). The sooner you get into the problem, the more likely you get the resolution. The best option would be not to create the opportunity but this is unfortunately applicable only in certain circumstances and would require, in the urban environment, the collaboration of all citizenship and administration. Easier and more applicable is to avoid the consumption in private gardens or at home with adequate cleaning and control of spaces.

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Un caso di coprofagia e di pica in un cane anziano ed epilettico

Sara Enrico

Medico Veterinario Esperto in Comportamento AVSE - AMBULATORIO VETERINARIO - Torino (Italy)

Sintesi

Un cane anziano, in terapia per epilessia fin dall'età di 3 anni, sviluppò un marcato comportamento di allo-coprofagia e alcuni episodi di pica.

Per valutare il comportamento, sono state prese in considerazione le cause multifattoriali: storia del paziente, trattamenti farmacologici e conseguente disfunzione epatica, problemi correlati con l'età e la motivazione sottostante.

È stato messo in pratica un protocollo di modificazione comportamentale, basato essenzialmente su un modello di contro-condizionamento, per ridurre i comportamenti indesiderati e i rischi correlati alla salute.

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